THE LIGHT PROPAGATION IN BIOLOGICAL TISSUE FOR CANCER TREATMENT.

H. S. Lim[1], D. J. Lee[2], J. M. Kim[2], S.H. Kim[2].
[1]Department of Biological Engineering, College of Medicine, Chungnam National University.
[2]Interdisciplinary Program in Biomedical Engineering, Chungnam National University.

Abstract-**This paper is to study the accessible depth by photons within biological tissue for Photodynamic Therapy of cancer. For the measurements of light propagation within tissue, we applied the diode Laser of 660nm wavelength and by assuming the medium to be homogeneous, we neglect the effects of any refractive index mismatches between the tissue layers. The result have yielded the penetration depth of light within biological tissue.**

***Keywords* - Photodynamic Therapy, Light Propagation, Diode Laser.**

I. INTRODUCTION

Photodynamic therapy is an effective method to treat cancer by means of light action on photosensitizer in tissue. It is considered that destroying effect is mainly due to the formation of singlet oxygen resulting from the interaction of light excited photosensitizer with molecular oxygen (triplet state in the ground state). So the destroying effect will be proportional to the rate of singlet oxygen formation which is in turn depends on light intensity, photosensitizer concentration and molecular oxygen concentration[1].

Proper intensity of laser could determined by the measurement of propagation of light within normal and cancer tissues. For the effective PDT, we should controlled the value of photosensitizer, power density of laser and supplied oxygen to tissue. Increasing the power density of laser has problem like heating damage of tissues from laser[2,3]. High intensity of laser leads interaciton of light excited photosensitizer with molecular oxygen activity. It makes the blood oxygen saturation decrease. The interaction is also decreased due to insufficient oxygen. Stopping of irradiation increase the interaction means that pulse type of irradiation is effective method for the PDT.

We measure the light propagation within biological tissue as post steps of determine the property condition of PDT like as intensity of laser power and irradiation time control.

II. METHODOLOGY

1. Experimental diode Laser System

Diode laser resonator, 660nm wavelength and 300mW maximum power, was used in this measurement. Diode laser system was consist of CPU, Key Input, LCD Display, Laser Resonator. Laser Power Supply and Laser Power controller. Fig.1. shows the block diagram of diode laser system.

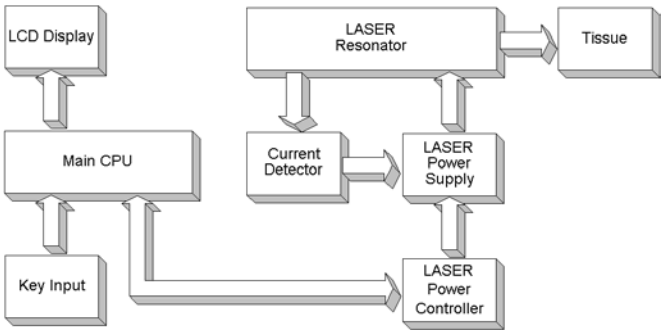

Fig. 1. Block Diagram of diode Laser.

Irradiation time and frequency were changed from 10m second to 99 second on/off time by setting for variable measurement conditions. Power density was also changed 10mW/cm^2 ~ 300mW/cm^2 by controller.

2. Measurement of light propagation

The characterstic of light within tissue is summarized reflection, absorption, scattering and penetration[4,5,6]. We measured scattering and penetration depth within biological tissue by spectroscopy. Fig. 2. shows measurement method. Light through the sample tissue was detected by spectrometer.

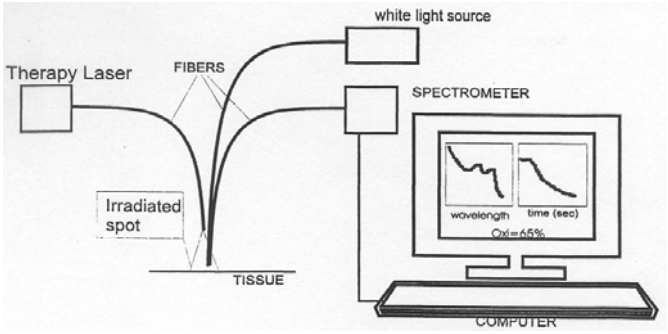

Fig. 2. Method of measurement of light propagation

We investigated the heating damage of tissue with microscope after exposed by continuous wave form. 200mW/cm2 of power density was free from heating damage. This power was fixed to peak power of pulse waveform. We measured power density through variable of tissue.

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
25 Oct 2001	N/A	-

Title and Subtitle The Light Propagation in Biological Tissue for Cancer Treatment	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Department of Biological Engineering College of Medicine Chungnam National University	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) US Army Research, Development & Standardization Group PSC 802 Box 15 FPO AE 09499-1500	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes
Papers from 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, October 25-28, 2001, held in Istanbul, Turkey. See also ADM001351 for entire conference on cd-rom., The original document contains color images.

Abstract

Subject Terms

Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU

Number of Pages
2

III. Results

We measured laser power density through the biological tissue. Power density after 12mm thickness tissue was reduced by half. Almost of the power was absorbed within 18mm thickness tissue. Same experiment results were obtained by comparing with continuous and pulse waveform.

Fig. 3. shows an example of the normalized light fluence rate in the tissue as a function time. In these measurements, the light was collected by an optical fiber and the measured fluence rate was divided by the direct laser-power output.

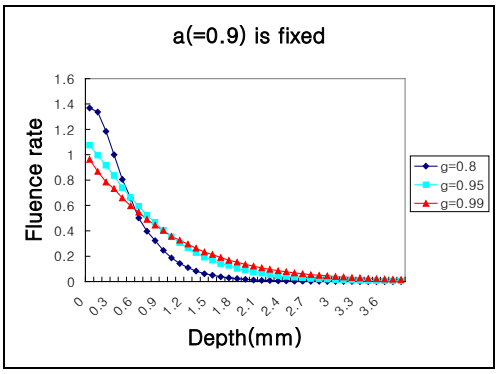

Fig. 3. Light Propagation within Biological Tissue.

IV. Discussion

Experiment result shows that pulse form of irradiation has same penetration depth with continuous waveform within tissue. It means that the property irradiation form is pulse for the PDT. Average energy of effective laser form was decreased. We just measured light propagation within normal biological tissue. The measurement of light propagation of laser within malignant cancer tissue and injected malignant cancer tissue with photosensitizer should be performed.

Acknowledgment

This study was supported by a grant of the Korea Health 21 R&D Project, Ministry of Helth & Welfare, Republic of Korea.(HMP-98-G-1-025)

References

[1] Stratonnikov A.A., Douplik A.J., Loschenov V.B. etal. “The Absorption Spectroscopy as a Tool to Control Blood Oxygen Saturation during Photodynamic Therapy”, SPIE, Vol. 3191, p.58-65, 1997.

[2] James S. Mccaughan, Jr., M.D. : A CLINICAL MANUAL PHOTODYNAMIC THERAPY OF MILIHNANCIES : CRC press. 1992.

[3] McCaughan Js Jr. Photodynamic therapy vs Nd-YAG laser treatment of endobronchial or esophageal malignancies in Photodynamic Therapy and Biomedical Lasers. Spinelli P, Dal Fante M and Marchesini R, Editors. Elsevier Science Publishers, pp 23-36, 1992.

[4] Keijzer M, Star W M and Storchi P R M 1998, Optical Diffusion in Layered Media, Appl. Opt., submitted.

[5] Ishimaru A 1978, Wave Propagation and Scattering in Random Media (New York. Academic Press).

[6] Hansen J E and Travis L D 1974, Light Scattering in Planetary Atmosphere, Space Sci. Rev. 16, 527-613.